

REMARKS

From the Summary page, claims 1, 3-5 and 9-12 were pending. Claims 9-12 are withdrawn from consideration as being directed to a non-elected invention. Claims 1 and 3-5 have been rejected.

Entry of the amendments is respectfully requested since entry would reduce the issues on appeals and does not introduce new matter. The amendments to Claim 1 clarify the sequence of the process steps. Support for the amendments can be found in the originally filed specification. No statutory new matter has been added.

Claim Rejections under 35 U.S.C. § 103 (a)

Claim 1 stands rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over Endo (US 6,429,518) in view of Redeker et al. (US 5,800,621), Okumura et al. (US 6,093,457), Endo et al. (U.S. Patent 6,197,704) and Suzuki (US 5,803,975). Schuegraf et al. ("Ultra-thin Silicon Dioxide Leakage Current and Scaling Limit", 1992 Symposium on VLSI Technology Digest of Technical Papers, pp. 18-19) is cited as evidence of material properties. Applicants respectfully traverse.

The claims are directed in large measure to the preparation of a specific fluorine-containing carbon film having specified upper level values for the dielectric constant, 2.3, and leakage current, 5×10^{-8} A/cm². This is attributed to a three-dimensional chain structure of CF₂ which results from the use of C₅F₈ as an educt and specific processing conditions, mean square velocity of 3 eV or below and electron density in the plasma producing space of 5×10^{11} electrons per cubic centimeter or above. The uniqueness of these conditions is evident from the background section of the present specification, on page 2, starting at line 26 where a trade off is described. The general process conditions of the invention are set forth starting on page 3 of the present specification at line 10. The results are clearly evident in Figures 5, 6, 7 and 8.

It is submitted that the art taken together does not recognize the goal, the starting material and the requisite conditions. The combined art has the appearances of being assembled with the aid of Applicants' specification.

Endo does not describe the structure of the claimed fluorine-containing carbon film nor does it specify the claimed characteristics- a relative dielectric constant of 2.3 or below and a leakage current of 5×10^{-8} A/cm² or below- or the processing conditions. It would appear that the claim conditions need to be taught as a combination not individually to achieve the desired end.

Endo appears to be concerned with adhesion between CF and SiO₂ films. See last two paragraphs of "Background Art" section. Endo teaches a C₄F₈/C₂H₄ mixture as an educt. (There is no criticality to suggest the selection of C₃F₈ from the possibilities taught in the paragraph bridging col. 16 and 17.) There is no mention of the combination of conditions required as required by the claimed step sequence. It appears that Endo recognizes that adhesion depends a ratio between Si atoms and N. See col. 8, starting at line 52. Endo even suggests the mixing of SiC film gases and CF film gases to improve adhesion. See paragraph bridging col.13 and 14. It is not seen how this guidance leads on to the selection of conditions that leads one to Applicants film and structure. (There is no possibility of an inherent teaching of the invention. The Endo process condition is distinct from those claimed). Serendipity is not obviousness.

The other references do not seem to lead one to the claimed process conditions. They too do not recognize the end product or how to get there. They do not suggest the need to modify the fluorine-containing carbon film of Endo or how that film would be modified to impart to it a dielectric constant of 2.3 or below and a leakage current of 5×10^{-8} A/cm² or below. The missing process conditions are not taught in a manner that one lead one to the performance of sequential steps under specified conditions that result in the film as claimed.

For example, at page 6, lines 15-19 in the Office Action, the Examiner has concluded by referring to Fig. 7 of Schuegraph and Endo ('704) that the teaching of Schuegraph and Endo would permit the formation of CF film which would have a leakage current of 5×10^{-9} A/cm². This teaching is not suggestive of an educt selection or process conditions. Further, it is well known that the dielectric constant of a CF film is lower than that of a SiO₂ film, and it is also well known that a leakage current of a CF film is larger than the leakage current of a SiO₂ film. Accordingly, it would be quite an accomplishment for persons skilled in this art to make a leakage current of a CF film as low as the leakage current of a SiO₂ film. While it might be

certain that a leakage current is proportional to amount of a parasitic capacity when a digital signal of alternating current (not direct current) flows in a multi-layered wiring structure, this does not provide the necessary guidance to achieve the desired end. Further, it should be noted that a leakage current in the present invention is a leakage current passed through a CF film itself and it is different from a parasitic capacity. A leakage current is a current which flows between the upper electrode and the lower electrode sandwiching a CF film when a direct voltage of 1 MV/cm (as shown in Figs. 6 and 7) is applied between the upper electrode and the lower electrode.

The Examiner seems to consider that it would be a just a designing matter to select the processing condition of an electron temperature of 2 eV or below, an electron density of 5×10^{11} electrons per cubic centimeter or above, and pressure of a processing atmosphere is 19.95 Pa or below. However, an electron temperature, an electron density and pressure of a processing atmosphere are very competitive and contradicting factors in "a plasma-assisted deposition method for forming an insulating film on a substrate placed on a support device in an airtight processing vessel by activating C_5F_8 gas by a plasma form gas". This is, for example, disclosed in page 2, line 4 to page 3, line 8. Then, it should be said the selection of the values of the processing condition of an electron temperature, an electron density and pressure of a processing atmosphere is not just a designing matter in this "a plasma-assisted deposition method for forming an insulating film on a substrate placed on a support device in an airtight processing vessel by activating C_5F_8 gas by a plasma forming gas". In the present invention, the concrete values of an electron temperature, an electron density and pressure of a processing atmosphere to be selected are discovered by Applicants' effort and ingenuity. For example, see page 11, line 36 to page 12, line 11 and page 12, line 21 to page 13, line 1.

As mentioned previously, the insulating film of a fluorine-containing carbon film of the present invention having a relative low dielectric constant and permitting a small leakage current (a relative dielectric constant of 2.3 or below and permitting a leakage current of 5×10^{-8} A/cm² or below) was attained for the first time when all the following requirements (a), (b) and (c) are fully satisfied (including both the characteristic features of the apparatus used and the processing

condition of an electron temperature, an electron density and pressure of a processing atmosphere(added at this time)).

It is submitted that a proper prima facie case has not been established. Withdrawal of the rejection is respectfully requested.

CONCLUSION

All of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Therefore, it is respectfully requested that the Examiner reconsider all presently outstanding rejections and that they be withdrawn. It is believed that a full and complete response has been made to the outstanding Office Action and, as such, the present application is in condition for allowance.


If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number provided.

It is not believed that extensions of time are required. However, in the event that additional extensions of time are necessary to prevent abandonment of this application, then such extensions of time are hereby petitioned under 37 C.F.R. § 1.136(a), and any fees required therefore are hereby authorized to be charged to **Deposit Account No. 02-4300, Attorney Docket No. 033082M280.**

Respectfully submitted,

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